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NATIONAL DAM SAFETY PROGRAM. HULEN LAKE DAM (MO 10726, MO 10975--ETC(U)
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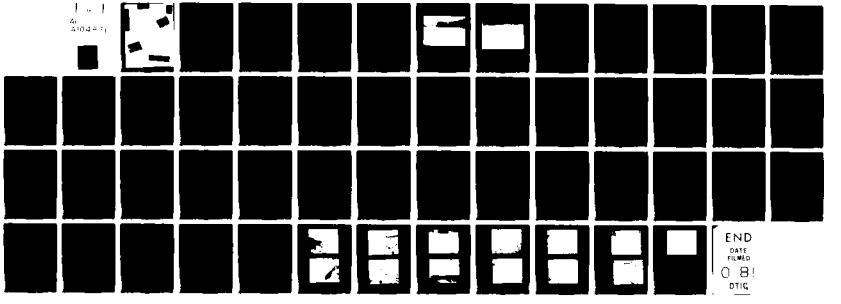

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This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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HULEN LAKE DAMS
BOONE COUNTY, MISSOURI
MISSOURI INVENTORY NOS. 10726 AND 10975

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY: ST. LOUIS DISTRICT CORPS OF ENGINEERS
FOR: GOVERNOR OF MISSOURI
AUGUST 1978

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Hulen Lake Dams
State Located: Missouri
County Located: Boone County
Stream: Tributary to County House Branch
Date of Inspection: 13 April 1978

Two Hulen Lake Dams were inspected by a team of engineers from the St. Louis District, U. S. Army Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dams with respect to safety, based upon available data and visual inspection, in order to determine if the dams pose hazards to human life or property. The assessment of the dam size and hazard classification was based on "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of Federal and State agencies, professional engineering organizations and private engineers.

Based on the guidelines, these dams are classified as intermediate size dams with high downstream hazard potential. Failure of either dam will significantly increase the potential for loss of life; serious damage to homes; and extensive damage to property downstream of the dam.

Based on hydraulic - hydrologic analysis, the concrete box spillway of the Hulen Lake Dams cannot pass a 50 percent Probable Maximum Flood (PMF) without overtopping and does not meet the criteria set forth in the guidelines for a dam of the size and hazard classification designated. The spillway will pass the one percent chance flood (100-year flood) or 20 percent of the PMF without overtopping with the assumption of no sudden collapses of Fairview Lake Dam (located upstream of Hulen). Overtopping is likely to cause a sudden failure of the dam. This dam is classified as unsafe for overtopping conditions discussed above. However, no conditions were observed that would pose an emergency at non-overtopping conditions.

Based on a visual inspection and available data, the dams have the following additional deficiencies which are considered to have an adverse effect on the safety of the dams:

a. Extensive erosion and undermining at the downstream end of the concrete spillway of Hulen Lake Dam West.

b. Extensive seepage observed downstream of the Hulen Dam West and along the left abutment of the Hulen Dam East.

c. Heavy vegetation and trees growing on the downstream slope of the dams.

d. None of the dams inspected have seepage or stability analyses records available. In accordance with the above guidelines, the absence of such records is a deficiency which should be rectified.

It is recommended that the owners take the necessary action in the near future to correct or control the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.

Ken Alexander
KEN ALEXANDER
Soils Engineer

Chien Hsieh
CHIEN (NANCY) HSIEH
Hydraulic Engineer

Submitted By _____ 21 Sept 78
Chief, Engineering Division Date

Approved By _____ 22 Sep 78
Colonel, CE, District Engineer Date

OVERVIEW OF HULEN LAKE DAM EAST

OVERVIEW OF HULEN LAKE DAM WEST

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
HULEN LAKE DAMS - ID NOS. 10726 AND 10975

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HULEN LAKE DAMS
ID NOS. 10726 and 10975

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed a safety inspection of the Hulen Lake Dams.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dams with respect to safety, based upon available data and visual inspection in order to determine if the dams pose hazards to human life or property.

c. Evaluation Guidelines. The inspection and evaluation were performed in accordance with the investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams" Appendix D, published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dams and Appurtenances.

(1) This project consists of two dams, Hulen Dam East (10975) and Hulen Dam West (10726). Both are earth structures north of the Missouri River near Columbia, Missouri. Topography near the dams is gently rolling and is shown on PLATE 1.

(2) The west dam is located approximately 2000 feet downstream of the Fairview Lake Dam and west of the east dam. There is a strip of land which divides the lakes of the east and west dams and their watersheds.

(3) The lake level of Hulen East Lake is governed by a 29-inch by 18-inch corrugated metal pipe-arch placed under the overbank abuting the ends of the Hulen Lake dams. The pipe-arch connects the East and West lakes and maintains the levels of the two lakes in equilibrium (See Photos 1 and 2). The lake level of Hulen West Lake is controlled by a 7-foot wide, 3-foot high and 48-foot long ungated

concrete box spillway at the east end of the embankment of the Hulen Lake Dam West. The box spillway with the flare headwalls upstream and concrete chute downstream is the only outlet for the drainage area above the dams All the water from the drainage area flows through the box spillway and over rock falls to the downstream river channel (See Photos 2-4).

(3) The pertinent physical data are given in paragraph 1.3 below and the general layout of the Hulen Lake Dams is shown on PLATE 3.

b. Location. The dams are located in the SW 1/4 of Section 15, T48N, R3W at west side of city of Columbia, Missouri, Boone County, as shown on PLATES 1 and 2.

c. Size Classification. The size classification of dams and impoundments is based on the height of the dam and storage capacity. The Hulen Lake Dams are categorized as the intermediate sizes (per the guidelines referenced in paragraph 1.1c above).

d. Hazard Classification. The Hulen Lake Dams are in the high hazard potential category.

e. Ownership. The dams are owned by the Lake Shore Estates Recreation Association, Inc., President of the association Dr. Ted Groshong, 918 Bourne Avenue, Columbia, Missouri 65201.

f. Purpose of Dam. The dams impounds water for the purpose of recreation.

g. Design and Construction History. The inspection team was unable to find any design data on these dams. Recent information obtained from Mr. Carl Hulen, the original owner, indicated that both dams were constructed during 1947-1948 by the Bill Goodson Construction Co.

h. Normal Operating Procedure. The levels of the lakes are controlled by the corrugated metal pipe-arch which connects the two lakes and the ungated concrete box spillway.

1.3 PERTINENT DATA

a. Drainage Areas.

(1) 51 Acres (Hulen Lake Dam East)
(2) 115 Acres (Between Fairview Lake Dam and Hulen Lake Dam West)
(3) 212 Acres (Hulen Lake Dam West) includes the drainage area above Fairview Lake Dam

b. Dishcarge at Damsites.

(1) All discharge at the damsite is through:
(a) 29-inch x 18-inch CMPA (Hulen Lake Dam East)
(b) 7-foot x 3-foot Concrete box spillway (Hulen Lake Dam West)

(2) Ungated spillway capacity at maximum pool elevation is:

(a) Varies, depends on the lake level difference beween East and West Lakes. (Hulen Lake Dam East).
(b) 110 cfs. (Hulen Lake Dam West)

c. Elevation. (feet above MSL)

(1) Top Dam - 676.2± (Hulen Lake Dam - East)
675.5± (Hulen Lake Dam - West)

(2) Stream bed at centerline of dam - 626 ± Est.

(3) Maximum tailwater - unknown

d. Reservoir.

(1) Length of Maximum Pool (feet)
(a) 1200 (Hulen Lake Dam East)
(b) 1700± (Hulen Lake Dam West)

e. Storage. (Acre - feet) - Hulen Lake West from 74 inventory.

(1) Recreation Pool 255
(2) Top of dam 283
(3) Storage of Hulen Lake Dam East - unknown

f. Reservoir Surface. (Acres)

(1) Top of dam
(a) 8± Est. (Hulen Lake Dam East)
(b) 17± (1974 inventory for Hulen Lake Dam West)

g. Dams.

(1) Type - earth embankment
(2) Length, (feet)
(a) 420 ± (Hulen Lake Dam East)
(b) 600 ± (Hulen Lake Dam West)

(3) Height, (feet) - 50 Est. (1974 inventory Hulen Lake Dams)

(4) Top width (feet)
(a) 23 ± (Hulen Lake Dam East)
(b) 18 ± (Hulen Lake Dam West)

(5) Side Slopes
Upstream - IV on 2+H
Downstream - IV on 2+H

h. Diversion and Regulating Tunnel. None

i. Spillway.

(1) Type and Size
(a) 29-inch x 18-inch x 84-foot CMPA (Hulen Lake Dam East)
(b) 7-foot x 3-foot x 48-foot concrete box (Hulen Lake Dam West)

(2) Invert elevation, (feet MSL) - 672.4 ±

j. Regulating Outlets. None

SECTION II - ENGINEERING DATA

2.1 DESIGN

Design data for these structures were not available.

2.2 CONSTRUCTION

The dams were constructed in 1947 and 1948 by the Bill Goodson Construction Company. The original owner (Mr. Carl Hulen) reported that a 15-foot ± core was excavated at the dams and all fill was clay from a hill which protruded into the west side of the west lake. All embankment material was compacted with a sheepsfoot roller.

2.3 OPERATION

No operational records were found. The west dam has a high level uncontrolled box spillway for controlling lake levels, and the east dam has no spillway, only a CMPA connecting to the West Lake to balance the lake levels between the two lakes.

2.4 EVALUATION

a. Availability. The only engineering data available were:

(1) An Engineering Geologic Report on Status of Hulen Lakes prepared by the Missouri Geological Survey, dated 6 November 1969.

(2) A design drawing of present concrete box spillway which replaced a portion of the original spillway of the west dam. The drawing dated 1 September 1970 was prepared by the "Architect-Engineers-Planners" Columbia, Missouri.

b. Adequacy. Engineering data is not available to make a detailed assessment of the design, construction, and operation. The owners should have an engineer experienced in design of dams perform detail seepage and stability analyses.

c. Validity. No valid engineering data were found on design or construction of these dams.

SECTION III - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the dams, outlet spillways and exit channels was made on 13 April 1978 by Corps of Engineers, St. Louis District personnel.

b. Dams. The dams that were inspected are: Hulen Lake Dam East and Hulen Lake Dam West. Locations, profiles, and sections of these dams are shown on PLATES 1 through 7.

No detrimental cracking, settlement, or slides were observed on either of these dams. Both of the dams have steep downstream slopes (approximately 1H to 2.2V) with heavy vegetation and tree growth (see Photos 5 and 6). A few trees were also growing on the upstream slope of each dam. Seepage was observed downstream of the east dam along the left abutment about two-thirds of the distance down from the top of the dam (see Photos 7). Two large seepage areas were observed downstream from the toe of the west dam (see Photos 8, 9, and 10). As shown in these photos, the seep water is reddish in color, indicating flow through a high iron content soil. The Missouri Geological Survey reported that these seeps were first noted by them in the early 1960's and have not visualy changed in size or flow. Flows were estimated between 10 gpm and 30 gpm. These seeps cover such a large area (approximately 150-foot x 300-foot) that it is difficult to accurately estimate the rate of flow.

Temperature of seep water was 46°F., indicating that seep water was apparently coming from the lower portion of the Lake. Temperature of lake surface water was approximately 50°F and normal groundwater is near 54°F.

The trunks of several trees on the downstream slope of the east dam were bowed downstream (see Photo 11). This condition may be caused by a very slow movement of the steep downstream slope. This slow movement may be what is known as soil creep and may continue to occur at a slow rate. No slope failure due to soil creep was8visible.

c. Appurtenant Structures. No exit outlet is provided for the Hulen Lake Dam East except a 29-inch x 18-inch x 84-foot CMPA connecting with the Hulen West Lake to balance the water level of

the two lakes. The invert of the pipewas approximately one-third silted and some water was flowing through the pipe on the day of inspection. (see Photo 1). The 7-foot x 3-foot x 48-foot concrete box spillway at the east end of the embankment of the Hulen Lake Dam West is the only outlet to release water from the drainage areas above the Hulen Lake Dams. Severe erosion and undermining has occurred at the downstream of the spillway chute (see Photos 12 and 13).

d. Lake Area. No wave wash, excessive erosion or slides were observed along the shore of the lake areas.

e. Downstream Channel. The box spillway of the west dam discharge flows over a series of rock falls to reach the original stream. Erosion along the toe of the west dam adjacent to the rock falls was noticed (see Photos 4 and 13).

3.2 EVALUATION

The deficiencies observed during this inspection and noted herein, if left uncontrolled or uncorrected, could lead to a serious potential for failure.

SECTION IV - OPERATIONAL PROCEDURE

4.1 PROCEDURES

There are no controlled outlet works for the dams; therefore, no regulating procedures exist. The pool is controlled by rainfall, runoff, evaporation, and the capacity of the uncontrolled spillway and outlet.

4.2 MAINTENANCE OF DAM

Based on the amount of vegetation on the downstream slope of these dams, no maintenance has been accomplished on these dams for several years.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at either of the dams.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for these dams.

4.5 EVALUATION

If lack of maintenance is allowed to continue, a serious potential for failure may develop

SECTION V - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data are not available.

b. Experience Data. The drainage area and lake surface area were obtained from the USGS Columbia and Huntsdale Qudrangles. The alinement of dams, spillways, and outlets were developed from surveys made during the inspection.

c. Visual Observations.

(1) Drawdown facilities necessary to evacuate the pools did not exist at either of the lakes.

(2) The observed condition of the spillway, culvert and exit channels are discussed in Section 3, paragraphs 3.1c and 3.1e.

d. Overtopping Potential. The box spillway of the west dam is too small to pass one-half of the probable maximum flood without overtopping. The probable maximum flood is defined as the flood that may be expected from the most severe combination of critical meteorologic amd hydrologic conditions that are reasonably possible in the region. The box spillway has capacity for passing a one percent chance flood (100 year flood) or 20 percent of the PMF without overtopping with the assumption of no sudden collapse of the Fairview Lake upstream. The east lake will store the entire one percent chance flood or 20 percent of the PMF. The one percent chance flood is a flood that would have a one percent chance of being exceeded in any given year. Routing one-half of the PMF through the lakes reveals that the dam would be overtopped for approximately 2.8 hours (east dam) or 6.83 hours (west dam) with the maximum of 0.5 feet (east dam) or 1.36 feet (west dam) water and 280 cfs (east dam) or 1300 cfs (west dam) discharge over the top of the dam. The summary of the hydrologic and hydraulic computations is presented in Appendix A. Overtopping of the magnitude described above is likely to cause sudden failure of the dam. The tsunami wave from a sudden failure of the Fairview Lake Dam may threaten the safety of the west dam.

SECTION VI - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Conditions observed which affect the structural stablity of the dams are disucssed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dams were found.

c. Operating Records. No appurtenant stuctures requiring operation exist at the dams.

d. Post Construction Changes. In the late 1960's the original spillway on the west dam partially collapsed. Plans for a new spillway were furnished to the inspection team by the owner. The plans dated 9/1/70 were prepared by the firm of Architects-Engineers-Planners of Columbia, Missouri. The new spillway was constructed in 1971.

e. Seismic Stability. Since these dams are located in Seismic Zone 1, it is not likely that an earthquake would occur of sufficient intensity to cause severe damage or failure of the dams.

SECTION VII - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. None of the dams inspected had seepage or stability analyses records. To assure that conventional safety margins exist, these records should be obtained. Seepage was visually observed downstream of the Hulen Lake Dam West and along the abutment contact on the Hulen Lake Dam East. Although this seepage does not show any signs of piping material, uncontrolled seepage of this kind can quickly become detrimental to the safety of the dam. Other deficiencies observed which could lead to unsafe conditions are:

(1) Heavy growth of vegetation and trees on the downstream slopes and a few trees on the upstream slopes of both dams

(2) Erosions at downstream end of the box spillway chute and the exit channel of the Hulen Lake Dam West.

(3) Inadequate spillways.

b. Adequacy of Information. Due to the lack of engineering design and construction data, the conclusions in this report were based on performance history and visual conditions. Guidelines furnished for inspection of dams requires that seepage and stability analyses be on file for each dam inspection. No such data were available for these dams.

c. Urgency. The stability and seepage data discussed in paragraph 7.1a above should be obtained to assure that conventional safety margins exist. Also, means of controlling the seepage referred to in paragraph 7.1a above should be accomplished. If stability or seepage analyses indicates an unsafe condition, the condition should be corrected. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the other deficiencies listed in paragraph 7.1a are not corrected they could continue to deteriorate and lead to a serious potential failure. Therefore, these deficiencies should be corrected or controlled in the near future.

d. Necessity for Phase II. Based on the results of the Phase I inspection, no Phase II inspection is recommended.

e. Seismic Stability. These dams are located in Seismic Zone 1. An earthquake of this magnitude is not expected to cause structure failure to these earth dams.

7.2 REMEDIAL MEASURES

a. Alternatives.

(1) The outlet size and/or height of the dams should be increased to pass the probable maximum flood without overtopping the dams or to use other positive means for protecting the dams from sudden failure due to overtopping.

(2) Use seepage study results to determine methods to control or eliminate seepage observed at the Hulen Dams.

(3) If stability analysis of the dams show an unacceptable factor of safety, methods of stabilizing the dams should be studied.

b. O&M Maintenance and Procedures. The following Operation and maintenance procedures are recommended:

(1) Remove trees and heavy vegetation from the slopes of the dams.

(2) Repair erosion and undermining and provide erosion protection and/or energy dissipators at the downstream end of the spillway on the Hulen Lake Dam West.

(3) Keep the culvert and spillway clean.

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 24-hour storm duration is assumed with total depth distributed over 6-hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6-hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The non-peak 6-hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by deduction of infiltration losses appropriate to the soil, land use, and antecedent moisture conditions.

2. The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillway, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillway, and top of dam are defined by elevation-discharge curves.

3. Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

4. The above methodology has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the attached computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

5. Hydrologic and Hydraulic Data.

a. The flow rate for the box spillway is determined by the capacity of the box with inlet control.

b. Very little flow is assumed to pass the connecting CMPA in the routing.

c. Weir formulas are used for the dam overtopping analyses.

$Q = 3.0LH^{1.5}$ for east dam
$Q = C' ZH^{2.5} = CH^{2.5}$ for west dam
$C' = 2.4$

$$Z = \frac{1}{2} \left(\frac{1}{S1} + -\frac{1}{S2}\right)$$

(S is the slope of the top of the dam ft./ft.) H = Head on the lowest point of the dam.

```
1    A1        DAM INSPECTION 13 APRIL 1978
2    A2      HULEN LAKE DAMES COLUMBIA MO    WEST LAKE
3    A3        SCS HYDROGRAPHS PMP AND 1PMP
4    B   288       0       5       0       0       0       0       0      -5       0
5    B1    5
6    J     1       2       1
7    J1    1     .25
8    K     0       1       0       0       1       0       1
9    K1      CALCULATION OF INFLOW HYDROGRAPH OF FAIRVIEW LAKE DAMS
10   M     1       2     .07       0       0       1       0      .0       1
11   P     0      25     102     121     130
12   T     0       0       0       0       0       0      -1     -85
13   W2    0     .07
14   X    30      40       2
15   K     1       2       0       0       0       0       1
16   K1      ROUTED FLOW THROUGH DROP INLET SPILLWAY AND 30 INCH CMP AND TOP OF DAM T
17   Y     0       0       0       1       1
18   Y1    1       0       0       0       0       0   -709.9      -1
19   Y4 709.9     710     711   711.9     713     718
20   Y5    1      32      40      45      50      70
21   SA    0     2.3     2.3     2.4     2.5     2.5     3.0
22   SE 677.3   709.9     710     711   711.9     713     718
23   SS 709.9
24   SD 711.5     120     2.5       1
25   K     0       3       0       0       1       0       1
26   K1      CALCULATION OF INFLOW HYDROGRAPH HULEN LAKE DAM EAST
27   M     1       2     .08       0       0       1       0       0       1
28   P     0      25     102     121     130
29   T     0       0       0       0       0       0      -1     -85
30   W2    0     .09
31   X    30      40       2
32   K     1       2       0       0       1       0       1
33   K1      ORDUTEING FLOW THRUOGH CONNECTING CMPA AND OVERBANK TO HULEN WEST
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```
35              Y1     1       0       0       0       0       0   -672.2      -1
36              Y4 672.2   674.2   675.5   676.2   676.7   686.2
37              Y5     0      10      10      50     100     100
38              SA     0     7.5     7.8       8     8.1     8.1     9.6
39              SE   626   672.2   674.2   675.5   676.2   676.7   686.2
40              SS 672.2
41              SD 675.5
42              K      0       2       0       0       1       0       1
43              K1       CALCULATION OF INFLOW HYDROGRAPH OF HULEN LAKE DAM WEST
44              M      1       2     .18       0       0       1       0       0       1
45              P      0      25     102     121     150
46              T      0       0       0       0       0       0      -1     -85
47              W2     0     .05
48              X     30      40       2
49              K      3       2       0       0       1       1       1
50              K1       COMBINED THREE HYDROGRAPHS
51              K      1       4       0       0       1       0       1
52              K1     ROUTING FLOW THROUGH 7 FT X 3 FT BOX AND TOP OF DAM TO DOWNSTREAM
53              Y      0       0       0       1       1
54              Y1     1       0       0       0       0       0   -672.4      -1
55              Y4 672.4   675.5     680     685
56              Y5     0     105     200     280
57              SA     0      17    17.7    18.6    19.8
58              SE 627.4   672.4   675.5     680     685
59              SS 672.4
60              SD 675.5     600     2.5       1
61              K     99
                PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                        RUNOFF HYDROGRAPH AT          1
                        ROUTE HYDROGRAPH TO           2
                        RUNOFF HYDROGRAPH AT          3
                        ROUTE HYDROGRAPH TO           2
                        RUNOFF HYDROGRAPH AT          2
                        COMBINE  3 HYDROGRAPHS AT     2
                        ROUTE HYDROGRAPH TO           4
                        END OF NETWORK
```

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH OF FAIRVIEW LAKE DAME

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	1	3	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.07	0.00	.07	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.00	102.00	121.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-85.00	0.00	0.00

CURVE NO = -85.00 WETNESS = -1.00 EFFECT CN = 85.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .07

RECESSION DATA

STRTQ= 30.00 QRCSN= 40.00 RTIOR= 2.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 6 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .07 VOL= 1.00

257. 203. 58. 17. 5. 2.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	28.	1.01	12.05	145	.21	.20	.01	69.
1.01	.10	2	.01	0.00	.01	26.	1.01	12.10	146	.21	.20	.01	97.
1.01	.15	3	.01	0.00	.01	24.	1.01	12.15	147	.21	.20	.01	105.
1.01	.20	4	.01	0.00	.01	23.	1.01	12.20	148	.21	.20	.01	108.
1.01	.25	5	.01	0.00	.01	21.	1.01	12.25	149	.21	.20	.01	109.
1.01	.30	6	.01	0.00	.01	20.	1.01	12.30	150	.21	.20	.01	110.
1.01	.35	7	.01	0.00	.01	18.	1.01	12.35	151	.21	.20	.01	110.
1.01	.40	8	.01	0.00	.01	17.	1.01	12.40	152	.21	.20	.01	110.
1.01	.45	9	.01	0.00	.01	16.	1.01	12.45	153	.21	.20	.01	110.
1.01	.50	10	.01	0.00	.01	15.	1.01	12.50	154	.21	.20	.01	111.
1.01	.55	11	.01	0.00	.01	14.	1.01	12.55	155	.21	.20	.01	111.
1.01	1.00	12	.01	0.00	.01	13.	1.01	13.00	156	.21	.21	.01	111.
1.01	1.05	13	.01	0.00	.01	12.	1.01	13.05	157	.26	.25	.01	122.
1.01	1.10	14	.01	0.00	.01	11.	1.01	13.10	158	.26	.25	.01	130.
1.01	1.15	15	.01	0.00	.01	11.	1.01	13.15	159	.26	.25	.01	133.
1.01	1.20	16	.01	0.00	.01	10.	1.01	13.20	160	.26	.25	.01	134.
1.01	1.25	17	.01	0.00	.01	9.	1.01	13.25	161	.26	.25	.01	134.
1.01	1.30	18	.01	0.00	.01	9.	1.01	13.30	162	.26	.25	.01	134.
1.01	1.35	19	.01	0.00	.01	8.	1.01	13.35	163	.26	.25	.01	135.

1.01	1.55	23	.01	0.00	.01	6.
1.01	2.00	24	.01	0.00	.01	6.
1.01	2.05	25	.01	0.00	.01	5.
1.01	2.10	26	.01	0.00	.01	5.
1.01	2.15	27	.01	0.00	.01	5.
1.01	2.20	28	.01	0.00	.01	4.
1.01	2.25	29	.01	.00	.01	4.
1.01	2.30	30	.01	.00	.01	4.
1.01	2.35	31	.01	.00	.01	4.
1.01	2.40	32	.01	.00	.01	4.
1.01	2.45	33	.01	.00	.01	3.
1.01	2.50	34	.01	.00	.01	3.
1.01	2.55	35	.01	.00	.01	3.
1.01	3.00	36	.01	.00	.01	3.
1.01	3.05	37	.01	.00	.01	3.
1.01	3.10	38	.01	.00	.01	3.
1.01	3.15	39	.01	.00	.01	3.
1.01	3.20	40	.01	.00	.01	3.
1.01	3.25	41	.01	.00	.01	3.
1.01	3.30	42	.01	.00	.01	3.
1.01	3.35	43	.01	.00	.01	3.
1.01	3.40	44	.01	.00	.01	3.
1.01	3.45	45	.01	.00	.01	3.
1.01	3.50	46	.01	.00	.01	3.
1.01	3.55	47	.01	.00	.01	3.
1.01	4.00	48	.01	.00	.01	3.
1.01	4.05	49	.01	.00	.01	3.
1.01	4.10	50	.01	.00	.01	3.
1.01	4.15	51	.01	.00	.01	3.
1.01	4.20	52	.01	.00	.01	3.
1.01	4.25	53	.01	.00	.01	3.
1.01	4.30	54	.01	.00	.01	3.
1.01	4.35	55	.01	.00	.01	3.
1.01	4.40	56	.01	.00	.01	3.
1.01	4.45	57	.01	.00	.01	3.
1.01	4.50	58	.01	.00	.01	3.
1.01	4.55	59	.01	.00	.01	3.
1.01	5.00	60	.01	.00	.01	3.
1.01	5.05	61	.01	.00	.01	3.
1.01	5.10	62	.01	.00	.01	3.
1.01	5.15	63	.01	.00	.01	3.
1.01	5.20	64	.01	.00	.01	3.
1.01	5.25	65	.01	.00	.01	3.
1.01	5.30	66	.01	.00	.01	3.
1.01	5.35	67	.01	.00	.01	3.
1.01	5.40	68	.01	.00	.01	3.
1.01	5.45	69	.01	.00	.01	3.
1.01	5.50	70	.01	.01	.01	3.
1.01	5.55	71	.01	.01	.01	3.
1.01	6.00	72	.01	.01	.01	3.
1.01	6.05	73	.07	.03	.04	9.
1.01	6.10	74	.07	.03	.04	14.
1.01	6.15	75	.07	.03	.03	17.
1.01	6.20	76	.07	.03	.03	18.
1.01	6.25	77	.07	.04	.03	19.
1.01	6.30	78	.07	.04	.03	20.
1.01	6.35	79	.07	.04	.03	20.

1.01	13.55	167	.26	.25	.01	135.
1.01	14.00	168	.26	.25	.01	135.
1.01	14.05	169	.32	.31	.01	152.
1.01	14.10	170	.32	.31	.01	164.
1.01	14.15	171	.32	.31	.01	168.
1.01	14.20	172	.32	.31	.01	169.
1.01	14.25	173	.32	.31	.00	170.
1.01	14.30	174	.32	.31	.00	170.
1.01	14.35	175	.32	.31	.00	170.
1.01	14.40	176	.32	.31	.00	170.
1.01	14.45	177	.32	.31	.00	170.
1.01	14.50	178	.32	.31	.00	170.
1.01	14.55	179	.32	.31	.00	171.
1.01	15.00	180	.32	.32	.00	171.
1.01	15.05	181	.19	.19	.00	139.
1.01	15.10	182	.39	.38	.00	165.
1.01	15.15	183	.39	.38	.00	195.
1.01	15.20	184	.58	.58	.01	254.
1.01	15.25	185	.68	.67	.01	320.
1.01	15.30	186	1.65	1.63	.01	599.
1.01	15.35	187	2.71	2.70	.02	1077.
1.01	15.40	188	1.07	1.06	.01	930.
1.01	15.45	189	.68	.67	.00	576.
1.01	15.50	190	.58	.58	.00	402.
1.01	15.55	191	.39	.39	.00	290.
1.01	16.00	192	.39	.39	.00	232.
1.01	16.05	193	.30	.30	.00	192.
1.01	16.10	194	.30	.30	.00	169.
1.01	16.15	195	.30	.30	.00	163.
1.01	16.20	196	.30	.30	.00	161.
1.01	16.25	197	.30	.30	.00	161.
1.01	16.30	198	.30	.30	.00	161.
1.01	16.35	199	.30	.30	.00	161.
1.01	16.40	200	.30	.30	.00	161.
1.01	16.45	201	.30	.30	.00	161.
1.01	16.50	202	.30	.30	.00	161.
1.01	16.55	203	.30	.30	.00	161.
1.01	17.00	204	.30	.30	.00	161.
1.01	17.05	205	.23	.23	.00	144.
1.01	17.10	206	.23	.23	.00	131.
1.01	17.15	207	.23	.23	.00	128.
1.01	17.20	208	.23	.23	.00	127.
1.01	17.25	209	.23	.23	.00	126.
1.01	17.30	210	.23	.23	.00	126.
1.01	17.35	211	.23	.23	.00	126.
1.01	17.40	212	.23	.23	.00	126.
1.01	17.45	213	.23	.23	.00	126.
1.01	17.50	214	.23	.23	.00	126.
1.01	17.55	215	.23	.23	.00	126.
1.01	18.00	216	.23	.23	.00	126.
1.01	18.05	217	.02	.02	.00	71.
1.01	18.10	218	.02	.02	.00	39.
1.01	18.15	219	.02	.02	.00	37.
1.01	18.20	220	.02	.02	.00	34.
1.01	18.25	221	.02	.02	.00	32.
1.01	18.30	222	.02	.02	.00	30.
1.01	18.35	223	.02	.02	.00	28.
					.02	.00	26.

1.01	6.55	83	.07	.04	.02	23.
1.01	7.00	84	.07	.04	.02	24.
1.01	7.05	85	.07	.05	.02	24.
1.01	7.10	86	.07	.05	.02	25.
1.01	7.15	87	.07	.05	.02	25.
1.01	7.20	88	.07	.05	.02	25.
1.01	7.25	89	.07	.05	.02	26.
1.01	7.30	90	.07	.05	.02	26.
1.01	7.35	91	.07	.05	.02	27.
1.01	7.40	92	.07	.05	.02	27.
1.01	7.45	93	.07	.05	.02	27.
1.01	7.50	94	.07	.05	.01	28.
1.01	7.55	95	.07	.05	.01	28.
1.01	8.00	96	.07	.05	.01	28.
1.01	8.05	97	.07	.05	.01	28.
1.01	8.10	98	.07	.05	.01	29.
1.01	8.15	99	.07	.05	.01	29.
1.01	8.20	100	.07	.05	.01	29.
1.01	8.25	101	.07	.05	.01	29.
1.01	8.30	102	.07	.05	.01	29.
1.01	8.35	103	.07	.05	.01	30.
1.01	8.40	104	.07	.06	.01	30.
1.01	8.45	105	.07	.06	.01	30.
1.01	8.50	106	.07	.06	.01	30.
1.01	8.55	107	.07	.06	.01	30.
1.01	9.00	108	.07	.06	.01	31.
1.01	9.05	109	.07	.06	.01	31.
1.01	9.10	110	.07	.06	.01	31.
1.01	9.15	111	.07	.06	.01	31.
1.01	9.20	112	.07	.06	.01	31.
1.01	9.25	113	.07	.06	.01	31.
1.01	9.30	114	.07	.06	.01	31.
1.01	9.35	115	.07	.06	.01	31.
1.01	9.40	116	.07	.06	.01	32.
1.01	9.45	117	.07	.06	.01	32.
1.01	9.50	118	.07	.06	.01	32.
1.01	9.55	119	.07	.06	.01	32.
1.01	10.00	120	.07	.06	.01	32.
1.01	10.05	121	.07	.06	.01	32.
1.01	10.10	122	.07	.06	.01	32.
1.01	10.15	123	.07	.06	.01	32.
1.01	10.20	124	.07	.06	.01	32.
1.01	10.25	125	.07	.06	.01	32.
1.01	10.30	126	.07	.06	.01	32.
1.01	10.35	127	.07	.06	.01	33.
1.01	10.40	128	.07	.06	.01	33.
1.01	10.45	129	.07	.06	.01	33.
1.01	10.50	130	.07	.06	.01	33.
1.01	10.55	131	.07	.06	.01	33.
1.01	11.00	132	.07	.06	.01	33.
1.01	11.05	133	.07	.06	.01	33.
1.01	11.10	134	.07	.06	.01	33.
1.01	11.15	135	.07	.06	.00	33.
1.01	11.20	136	.07	.06	.00	33.
1.01	11.25	137	.07	.06	.00	33.
1.01	11.30	138	.07	.06	.00	33.
1.01	11.35	139	.07	.06	.00	33.

1.01	18.55	227	.02	.02	.00	21.
1.01	19.00	228	.02	.02	.00	20.
1.01	19.05	229	.02	.02	.00	18.
1.01	19.10	230	.02	.02	.00	17.
1.01	19.15	231	.02	.02	.00	16.
1.01	19.20	232	.02	.02	.00	15.
1.01	19.25	233	.02	.02	.00	14.
1.01	19.30	234	.02	.02	.00	13.
1.01	19.35	235	.02	.02	.00	12.
1.01	19.40	236	.02	.02	.00	11.
1.01	19.45	237	.02	.02	.00	11.
1.01	19.50	238	.02	.02	.00	10.
1.01	19.55	239	.02	.02	.00	10.
1.01	20.00	240	.02	.02	.00	10.
1.01	20.05	241	.02	.02	.00	10.
1.01	20.10	242	.02	.02	.00	10.
1.01	20.15	243	.02	.02	.00	10.
1.01	20.20	244	.02	.02	.00	10.
1.01	20.25	245	.02	.02	.00	10.
1.01	20.30	246	.02	.02	.00	10.
1.01	20.35	247	.02	.02	.00	10.
1.01	20.40	248	.02	.02	.00	10.
1.01	20.45	249	.02	.02	.00	10.
1.01	20.50	250	.02	.02	.00	10.
1.01	20.55	251	.02	.02	.00	10.
1.01	21.00	252	.02	.02	.00	10.
1.01	21.05	253	.02	.02	.00	10.
1.01	21.10	254	.02	.02	.00	10.
1.01	21.15	255	.02	.02	.00	10.
1.01	21.20	256	.02	.02	.00	10.
1.01	21.25	257	.02	.02	.00	10.
1.01	21.30	258	.02	.02	.00	10.
1.01	21.35	259	.02	.02	.00	10.
1.01	21.40	260	.02	.02	.00	10.
1.01	21.45	261	.02	.02	.00	10.
1.01	21.50	262	.02	.02	.00	10.
1.01	21.55	263	.02	.02	.00	10.
1.01	22.00	264	.02	.02	.00	10.
1.01	22.05	265	.02	.02	.00	10.
1.01	22.10	266	.02	.02	.00	10.
1.01	22.15	267	.02	.02	.00	10.
1.01	22.20	268	.02	.02	.00	10.
1.01	22.25	269	.02	.02	.00	10.
1.01	22.30	270	.02	.02	.00	10.
1.01	22.35	271	.02	.02	.00	10.
1.01	22.40	272	.02	.02	.00	10.
1.01	22.45	273	.02	.02	.00	10.
1.01	22.50	274	.02	.02	.00	10.
1.01	22.55	275	.02	.02	.00	10.
1.01	23.00	276	.02	.02	.00	10.
1.01	23.05	277	.02	.02	.00	10.
1.01	23.10	278	.02	.02	.00	10.
1.01	23.15	279	.02	.02	.00	10.
1.01	23.20	280	.02	.02	.00	10.
1.01	23.25	281	.02	.02	.00	10.
1.01	23.30	282	.02	.02	.00	10.
1.01	23.35	283	.02	.02	.00	10.
1.01	23.40	284	.02	.02	.00	10.

1.01	11.55	143	.07	.06	.00	33.	1.01	23.55	287	.02	.02	.00	10.
1.01	12.00	144	.07	.06	.00	33.	1.02	0.00	288	.02	.02	.00	10.
									SUM	32.50	30.47	2.03	17140.
										(825.)(	774.)(	51.)(	485.55)

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1          A1       DAM INSPECTION 13 APRIL 1978
2          A2     HULEN LAKE DAM EAST COLUMBIA MO   EAST L  E
3          A3       SCS HYDROGRAPHS PMP AND 1PMP
4          B   288      0       5       0       0       0       0       0      -5       0
5          B1    5
6          J     1      4       1
7          J1  1.0     .2      .3      .5
8          K     0      1       0       0       1       3       1
9          K1       CALCULATION OF INFLOW HYDROGRAPH OF HULEN LAKE DAM EAST
10         M     1      2     .08       0       0       1       0       0      1
11         P     0     25     102     121     130
12         T     0      0       0       0       0       0      -1     -85
13         W2    0    .09
14         X    30-    40       2
15         K     1      2       0       0       0       0       1
16         K1       ROUTED FLOW THROUGH CONNECTING CMPA AND TOP OF DAM
17         Y     0      0       0       1       1
18         Y1    1      0       0       0       0       0   -672.2      -1
19         Y4 672.2  674.2   675.5   676.2   676.7   686.2
20         Y5    0     10      10      50     120     120
21         SA    0    7.5     7.8     8.0     8.1     8.1     9.6
22         SE 626.0  672.2   674.2   675.5   676.2   676.7   686.2
23         SS 672.2
24         SD 676.2    3.0     1.5     280
25         K    99
                    PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                              RUNOFF HYDROGRAPH AT          1
                              ROUTE HYDROGRAPH TO           2
                              END OF NETWORK
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AH SAFETY VERSION JULY 1978
LAST MODIFICATION 29 AUG 78
****

UN DATE= 78/09/01,
TIME= 13.05.58.

DAM INSPECTION 13 APRIL 1978
HULEN LAKE DAM EAST COLUMBIA MO
SCS HYDROGRAPHS PMP AND 1PMP

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	-5	0

JOPEN	NWT	LROPT	TRACE
5	0	0	0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH OF HULEN LAKE DAM EAS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	1	3	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.08	0.00	.08	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.00	102.00	121.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIDL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-85.00	0.00	0.00

CURVE NO = -85.00 WETNESS = -1.00 EFFECT CN = 85.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .09

RECESSION DATA
STRTQ= 30.00 QRCSN= 40.00 RTIOR= 2.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 7 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .09 VOL= 1.00
209. 259. 97. 35. 13. 4. 2.

END-OF-PERIOD FLOW

0 HQ,DA	HR,MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	HQ,DA	HR,MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1	01	0.00	01				2A	1 01	12.05	185	.21	.20	.01	97.

1.01	.20	4	.01	0.00	.01	23.	1.01	12.20	148	.21	.20	.01	122.
1.01	.25	5	.01	0.00	.01	21.	1.01	12.25	149	.21	.20	.01	124.
1.01	.30	6	.01	0.00	.01	20.	1.01	12.30	150	.21	.20	.01	125.
1.01	.35	7	.01	0.00	.01	18.	1.01	12.35	151	.21	.20	.01	126.
1.01	.40	8	.01	0.00	.01	17.	1.01	12.40	152	.21	.20	.01	126.
1.01	.45	9	.01	0.00	.01	16.	1.01	12.45	153	.21	.20	.01	126.
1.01	.50	10	.01	0.00	.01	15.	1.01	12.50	154	.21	.20	.01	126.
1.01	.55	11	.01	0.00	.01	14.	1.01	12.55	155	.21	.20	.01	127.
1.01	1.00	12	.01	0.00	.01	13.	1.01	13.00	156	.21	.21	.01	127.
1.01	1.05	13	.01	0.00	.01	12.	1.01	13.05	157	.26	.25	.01	136.
1.01	1.10	14	.01	0.00	.01	11.	1.01	13.10	158	.26	.25	.01	147.
1.01	1.15	15	.01	0.00	.01	11.	1.01	13.15	159	.26	.25	.01	151.
1.01	1.20	16	.01	0.00	.01	10.	1.01	13.20	160	.26	.25	.01	152.
1.01	1.25	17	.01	0.00	.01	9.	1.01	13.25	161	.26	.25	.01	153.
1.01	1.30	18	.01	0.00	.01	9.	1.01	13.30	162	.26	.25	.01	154.
1.01	1.35	19	.01	0.00	.01	8.	1.01	13.35	163	.26	.25	.01	154.
1.01	1.40	20	.01	0.00	.01	8.	1.01	13.40	164	.26	.25	.01	154.
1.01	1.45	21	.01	0.00	.01	7.	1.01	13.45	165	.26	.25	.01	154.
1.01	1.50	22	.01	0.00	.01	7.	1.01	13.50	166	.26	.25	.01	154.
1.01	1.55	23	.01	0.00	.01	6.	1.01	13.55	167	.26	.25	.01	154.
1.01	2.00	24	.01	0.00	.01	6.	1.01	14.00	168	.26	.25	.01	155.
1.01	2.05	25	.01	0.00	.01	5.	1.01	14.05	169	.32	.31	.01	168.
1.01	2.10	26	.01	0.00	.01	5.	1.01	14.10	170	.32	.31	.01	184.
1.01	2.15	27	.01	0.00	.01	5.	1.01	14.15	171	.32	.31	.01	190.
1.01	2.20	28	.01	0.00	.01	4.	1.01	14.20	172	.32	.31	.01	193.
1.01	2.25	29	.01	.00	.01	4.	1.01	14.25	173	.32	.31	.00	194.
1.01	2.30	30	.01	.00	.01	4.	1.01	14.30	174	.32	.31	.00	194.
1.01	2.35	31	.01	.00	.01	4.	1.01	14.35	175	.32	.31	.00	194.
1.01	2.40	32	.01	.00	.01	4.	1.01	14.40	176	.32	.31	.00	195.
1.01	2.45	33	.01	.00	.01	3.	1.01	14.45	177	.32	.31	.00	195.
1.01	2.50	34	.01	.00	.01	3.	1.01	14.50	178	.32	.31	.00	195.
1.01	2.55	35	.01	.00	.01	3.	1.01	14.55	179	.32	.31	.00	195.
1.01	3.00	36	.01	.00	.01	3.	1.01	15.00	180	.32	.32	.00	195.
1.01	3.05	37	.01	.00	.01	3.	1.01	15.05	181	.19	.19	.00	169.
1.01	3.10	38	.01	.00	.01	3.	1.01	15.10	182	.39	.38	.00	177.
1.01	3.15	39	.01	.00	.01	3.	1.01	15.15	183	.39	.38	.00	215.
1.01	3.20	40	.01	.00	.01	3.	1.01	15.20	184	.58	.58	.01	270.
1.01	3.25	41	.01	.00	.01	3.	1.01	15.25	185	.68	.67	.01	345.
1.01	3.30	42	.01	.00	.01	3.	1.01	15.30	186	1.65	1.63	.01	591.
1.01	3.35	43	.01	.00	.01	3.	1.01	15.35	187	2.71	2.70	.02	1079.
1.01	3.40	44	.01	.00	.01	3.	1.01	15.40	188	1.07	1.06	.01	1112.
1.01	3.45	45	.01	.00	.01	3.	1.01	15.45	189	.68	.67	.00	747.
1.01	3.50	46	.01	.00	.01	3.	1.01	15.50	190	.58	.58	.00	518.
1.01	3.55	47	.01	.00	.01	3.	1.01	15.55	191	.39	.39	.00	376.
1.01	4.00	48	.01	.00	.01	3.	1.01	16.00	192	.39	.39	.00	289.
1.01	4.05	49	.01	.00	.01	3.	1.01	16.05	193	.30	.30	.00	238.
1.01	4.10	50	.01	.00	.01	3.	1.01	16.10	194	.30	.30	.00	202.
1.01	4.15	51	.01	.00	.01	3.	1.01	16.15	195	.30	.30	.00	190.
1.01	4.20	52	.01	.00	.01	3.	1.01	16.20	196	.30	.30	.00	185.
1.01	4.25	53	.01	.00	.01	3.	1.01	16.25	197	.30	.30	.00	184.
1.01	4.30	54	.01	.00	.01	3.	1.01	16.30	198	.30	.30	.00	184.
1.01	4.35	55	.01	.00	.01	3.	1.01	16.35	199	.30	.30	.00	183.
1.01	4.40	56	.01	.00	.01	3.	1.01	16.40	200	.30	.30	.00	183.
1.01	4.45	57	.01	.00	.01	3.	1.01	16.45	201	.30	.30	.00	184.
1.01	4.50	58	.01	.00	.01	3.	1.01	16.50	202	.30	.30	.00	184.
1.01	4.55	59	.01	.00	.01	3.	1.01	16.55	203	.30	.30	.00	184.
							1.01	17.00	204	.30	.30	.00	184.

1.01	5.20	64	.01	.00	.01	3.	1.01	17.20	208	.23	.23	.00	145.	
1.01	5.25	65	.01	.00	.01	3.	1.01	17.25	209	.23	.23	.00	145.	
1.01	5.30	66	.01	.00	.01	3.	1.01	17.30	210	.23	.23	.00	144.	
1.01	5.35	67	.01	.00	.01	3.	1.01	17.35	211	.23	.23	.00	144.	
1.01	5.40	68	.01	.00	.01	3.	1.01	17.40	212	.23	.23	.00	144.	
1.01	5.45	69	.01	.00	.01	3.	1.01	17.45	213	.23	.23	.00	144.	
1.01	5.50	70	.01	.01	.01	3.	1.01	17.50	214	.23	.23	.00	144.	
1.01	5.55	71	.01	.01	.01	3.	1.01	17.55	215	.23	.23	.00	144.	
1.01	6.00	72	.01	.01	.01	3.	1.01	18.00	216	.23	.23	.00	144.	
1.01	6.05	73	.07	.03	.04	8.	1.01	18.05	217	.02	.02	.00	100.	
1.01	6.10	74	.07	.03	.04	15.	1.01	18.10	218	.02	.02	.00	44.	
1.01	6.15	75	.07	.03	.03	18.	1.01	18.15	219	.02	.02	.00	38.	
1.01	6.20	76	.07	.03	.03	20.	1.01	18.20	220	.02	.02	.00	35.	
1.01	6.25	77	.07	.04	.03	21.	1.01	18.25	221	.02	.02	.00	33.	
1.01	6.30	78	.07	.04	.03	22.	1.01	18.30	222	.02	.02	.00	31.	
1.01	6.35	79	.07	.04	.03	23.	1.01	18.35	223	.02	.02	.00	29.	
1.01	6.40	80	.07	.04	.03	24.	1.01	18.40	224	.02	.02	.00	27.	
1.01	6.45	81	.07	.04	.02	25.	1.01	18.45	225	.02	.02	.00	25.	
1.01	6.50	82	.07	.04	.02	25.	1.01	18.50	226	.02	.02	.00	23.	
1.01	6.55	83	.07	.04	.02	26.	1.01	18.55	227	.02	.02	.00	22.	
1.01	7.00	84	.07	.04	.02	27.	1.01	19.00	228	.02	.02	.00	20.	
1.01	7.05	85	.07	.05	.02	27.	1.01	19.05	229	.02	.02	.00	19.	
1.01	7.10	86	.07	.05	.02	28.	1.01	19.10	230	.02	.02	.00	18.	
1.01	7.15	87	.07	.05	.02	28.	1.01	19.15	231	.02	.02	.00	16.	
1.01	7.20	88	.07	.05	.02	29.	1.01	19.20	232	.02	.02	.00	15.	
1.01	7.25	89	.07	.05	.02	29.	1.01	19.25	233	.02	.02	.00	14.	
1.01	7.30	90	.07	.05	.02	30.	1.01	19.30	234	.02	.02	.00	13.	
1.01	7.35	91	.07	.05	.02	30.	1.01	19.35	235	.02	.02	.00	12.	
1.01	7.40	92	.07	.05	.02	31.	1.01	19.40	236	.02	.02	.00	12.	
1.01	7.45	93	.07	.05	.02	31.	1.01	19.45	237	.02	.02	.00	12.	
1.01	7.50	94	.07	.05	.01	31.	1.01	19.50	238	.02	.02	.00	12.	
1.01	7.55	95	.07	.05	.01	32.	1.01	19.55	239	.02	.02	.00	12.	
1.01	8.00	96	.07	.05	.01	32.	1.01	20.00	240	.02	.02	.00	12.	
1.01	8.05	97	.07	.05	.01	32.	1.01	20.05	241	.02	.02	.00	12.	
1.01	8.10	98	.07	.05	.01	33.	1.01	20.10	242	.02	.02	.00	12.	
1.01	8.15	99	.07	.05	.01	33.	1.01	20.15	243	.02	.02	.00	12.	
1.01	8.20	100	.07	.05	.01	33.	1.01	20.20	244	.02	.02	.00	12.	
1.01	8.25	101	.07	.05	.01	33.	1.01	20.25	245	.02	.02	.00	12.	
1.01	8.30	102	.07	.05	.01	34.	1.01	20.30	246	.02	.02	.00	12.	
1.01	8.35	103	.07	.05	.01	34.	1.01	20.35	247	.02	.02	.00	12.	
1.01	8.40	104	.07	.06	.01	34.	1.01	20.40	248	.02	.02	.00	12.	
1.01	8.45	105	.07	.06	.01	34.	1.01	20.45	249	.02	.02	.00	12.	
1.01	8.50	106	.07	.06	.01	34.	1.01	20.50	250	.02	.02	.00	12.	
1.01	8.55	107	.07	.06	.01	35.	1.01	20.55	251	.02	.02	.00	12.	
1.01	9.00	108	.07	.06	.01	35.	1.01	21.00	252	.02	.02	.00	12.	
1.01	9.05	109	.07	.06	.01	35.	1.01	21.05	253	.02	.02	.00	12.	
1.01	9.10	110	.07	.06	.01	35.	1.01	21.10	254	.02	.02	.00	12.	
1.01	9.15	111	.07	.06	.01	35.	1.01	21.15	255	.02	.02	.00	12.	
1.01	9.20	112	.07	.06	.01	35.	1.01	21.20	256	.02	.02	.00	12.	
1.01	9.25	113	.07	.06	.01	36.	1.01	21.25	257	.02	.02	.00	12.	
1.01	9.30	114	.07	.06	.01	36.	1.01	21.30	258	.02	.02	.00	12.	
1.01	9.35	115	.07	.06	.01	36.	1.01	21.35	259	.02	.02	.00	12.	
1.01	9.40	116	.07	.06	.01	36.	1.01	21.40	260	.02	.02	.00	12.	
1.01	9.45	117	.07	.06	.01	36.	1.01	21.45	261	.02	.02	.00	12.	
1.01	9.50	118	.07	.06	.01	36.	1.01	21.50	262	.02	.02	.00	12.	
1.01	9.55	119	.07	.06	.01	36.	1.01	21.55	263	.02	.02	.00	12.	
1.01	10.00	120	.07	.06	.01	36.	1.01	22.00	264	.02	.02	.00	12.	

1.01	10.20	124	.07	.06	.01	37.	1.01	22.20	268	.02	.02	.00	12.
1.01	10.25	125	.07	.06	.01	37.	1.01	22.25	269	.02	.02	.00	12.
1.01	10.30	126	.07	.06	.01	37.	1.01	22.30	270	.02	.02	.00	12.
1.01	10.35	127	.07	.06	.01	37.	1.01	22.35	271	.02	.02	.00	12.
1.01	10.40	128	.07	.06	.01	37.	1.01	22.40	272	.02	.02	.00	12.
1.01	10.45	129	.07	.06	.01	37.	1.01	22.45	273	.02	.02	.00	12.
1.01	10.50	130	.07	.06	.01	37.	1.01	22.50	274	.02	.02	.00	12.
1.01	10.55	131	.07	.06	.01	37.	1.01	22.55	275	.02	.02	.00	12.
1.01	11.00	132	.07	.06	.01	38.	1.01	23.00	276	.02	.02	.00	12.
1.01	11.05	133	.07	.06	.01	38.	1.01	23.05	277	.02	.02	.00	12.
1.01	11.10	134	.07	.06	.01	38.	1.01	23.10	278	.02	.02	.00	12.
1.01	11.15	135	.07	.06	.00	38.	1.01	23.15	279	.02	.02	.00	12.
1.01	11.20	136	.07	.06	.00	38.	1.01	23.20	280	.02	.02	.00	12.
1.01	11.25	137	.07	.06	.00	38.	1.01	23.25	281	.02	.02	.00	12.
1.01	11.30	138	.07	.06	.00	38.	1.01	23.30	282	.02	.02	.00	12.
1.01	11.35	139	.07	.06	.00	38.	1.01	23.35	283	.02	.02	.00	12.
1.01	11.40	140	.07	.06	.00	38.	1.01	23.40	284	.02	.02	.00	12.
1.01	11.45	141	.07	.06	.00	38.	1.01	23.45	285	.02	.02	.00	12.
1.01	11.50	142	.07	.06	.00	38.	1.01	23.50	286	.02	.02	.00	12.
1.01	11.55	143	.07	.06	.00	38.	1.01	23.55	287	.02	.02	.00	12.
1.01	12.00	144	.07	.06	.00	38.	1.02	0.00	288	.02	.02	.00	12.
									SUM	32.50	30.47	2.03	19478.
										(825.)(774.)(51.)(551.56)			

PEAK OUT W IS 37. AT TIME 18.00 HOURS

PEAK OUTFLOW IS 393. AT TIME 15.75 HOURS

1

EAST LAKE

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .20	RATIO 3 .30	RATIO 4 .50
HYDROGRAPH AT	1	.08	1	1112.	222.	334.	556.
	(	.21)	(	31.49)(	6.30)(	9.45)(	15.74)(
ROUTED TO	2	.08	1	934.	10.	37.	393.
	(	.21)	(	26.45)(	.28)(	1.06)(	11.13)(

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	672.20	672.20	676.20
STORAGE	116.	116.	147.
OUTFLOW	0.	0.	50.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	677.23	1.03	155.	934.	4.83	15.67	0.00
.20	674.95	0.00	137.	10.	0.00	15.75	0.00
.30	675.98	0.00	145.	37.	0.00	18.00	0.00
.50	676.68	.48	151.	393.	2.75	15.75	0.00

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 29 AUG 78
****

COMBINE HYDROGRAPHS

COMBINED THREE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	3	0	0	1	1	1	0	0

SUM OF 3 HYDROGRAPHS AT 2 PLAN 1 RTIO 1

46.	50.	49.	47.	45.	42.	40.	37.	35.	33.
30.	29.	27.	25.	24.	22.	21.	19.	18.	17.
16.	15.	14.	13.	13.	12.	11.	11.	10.	10.
9.	9.	9.	9.	9.	9.	9.	9.	9.	9.
9.	9.	9.	9.	9.	9.	9.	9.	9.	9.
9.	10.	10.	10.	10.	10.	10.	10.	10.	11.
11.	11.	11.	11.	11.	11.	11.	12.	12.	12.
12.	12.	56.	50.	59.	64.	68.	72.	75.	77.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
109.	110.	111.	112.	112.	113.	114.	115.	115.	116.
117.	117.	118.	118.	119.	119.	120.	120.	121.	121.
122.	122.	123.	123.	123.	124.	124.	124.	125.	125.
125.	125.	126.	126.	126.	127.	127.	127.	127.	128.
128.	128.	128.	128.	257.	308.	322.	327.	330.	332.
334.	336.	338.	345.	357.	371.	424.	459.	481.	497.
508.	517.	524.	530.	539.	548.	556.	563.	632.	672.
646.	654.	658.	661.	662.	663.	664.	665.	666.	667.
544.	673.	746.	973.	1194.	2305.	4072.	3194.	2056.	1487.
1090.	920.	768.	699.	672.	662.	658.	656.	656.	656.
656.	656.	657.	657.	594.	561.	548.	542.	539.	538.
537.	537.	537.	537.	537.	537.	325.	224.	197.	184.
175.	169.	163.	159.	156.	154.	154.	153.	152.	152.
151.	150.	150.	149.	148.	147.	146.	145.	145.	144.
143.	142.	141.	140.	139.	139.	138.	136.	122.	117.
116.	115.	114.	114.	113.	113.	113.	113.	112.	112.
112.	112.	111.	111.	111.	111.	110.	110.	110.	110.
109.	109.	109.	109.	108.	108.	108.	108.	108.	107.
107.	107.	107.	106.	106.	106.	106.	105.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4072.	721.	244.	244.	70273.
CMS	115.	20.	7.	7.	1990.
INCHES		20.32	27.51	27.51	27.51
MM		516.11	698.82	698.82	698.82
AC-FT		357.	484.	484.	484.
THOUS CU M		441.	597.	597.	597.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
672.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
675.5	600.0	2.5	1.

PEAK OUTFLOW IS 3495. AT TIME 15.67 HOURS

PEAK OUTFLOW IS 94. AT TIME 18.08 HOURS

PEAK OUTFLOW IS 219. AT TIME 16.17 HOURS

PEAK OUTFLOW IS 1428. AT TIME 15.67 HOURS

1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .20	RATIO 3 .30	RATIO 4 .50
HYDROGRAPH AT	1	.07	1	1077.	215.	323.	538.
		(.18)		(30.50)(	6.10)(	9.15)(	15.25)(
ROUTED TO	2	.07	1	1026.	47.	195.	486.
		(.18)		(29.05)(	1.32)(	5.52)(	13.77)(
HYDROGRAPH AT	3	.08	1	1112.	222.	334.	556.
		(.21)		(31.49)(	6.30)(	9.45)(	15.74)(
ROUTED TO	2	.08	1	94.	10.	37.	98.
		(.21)		(2.65)(	.28)(	1.06)(	2.77)(
HYDROGRAPH AT	2	.18	1	3160.	632.	948.	1580.
		(.47)		(89.49)(	17.90)(	26.85)(	44.74)(
3 COMBINED	2	.33	1	4072.	678.	1014.	1992.
		(.85)		(115.30)(	19.20)(	28.72)(	56.40)(
ROUTED TO	4	.33	1	3495.	94.	219.	1428.
		(.85)		(98.95)(	2.65)(	6.19)(	40.43)(

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN : FAIRVIEW LAKE DAM

	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
		709.90	709.90	711.50
		25.	25.	29.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	713.81	2.31	35.	1026.	6.25	15.67	0.00
.20	711.72	.22	29.	47.	.83	16.00	0.00
.30	712.58	1.08	31.	195.	2.58	15.75	0.00
.50	713.18	1.68	33.	486.	4.50	15.67	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 EASTLAKE SCS OVERTOPPING ANALYSIS OF HULEN DAM EAST

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	672.20	672.20	675.50
STORAGE	116.	116.	141.
OUTFLOW	0.	0.	10.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	683.49	7.99	209.	94.	10.92	14.17	0.00
.20	674.95	0.00	137.	10.	0.00	15.75	0.00
.30	675.98	.48	145.	37.	5.17	18.00	0.00
.50	678.02	2.52	162.	98.	8.92	20.92	0.00

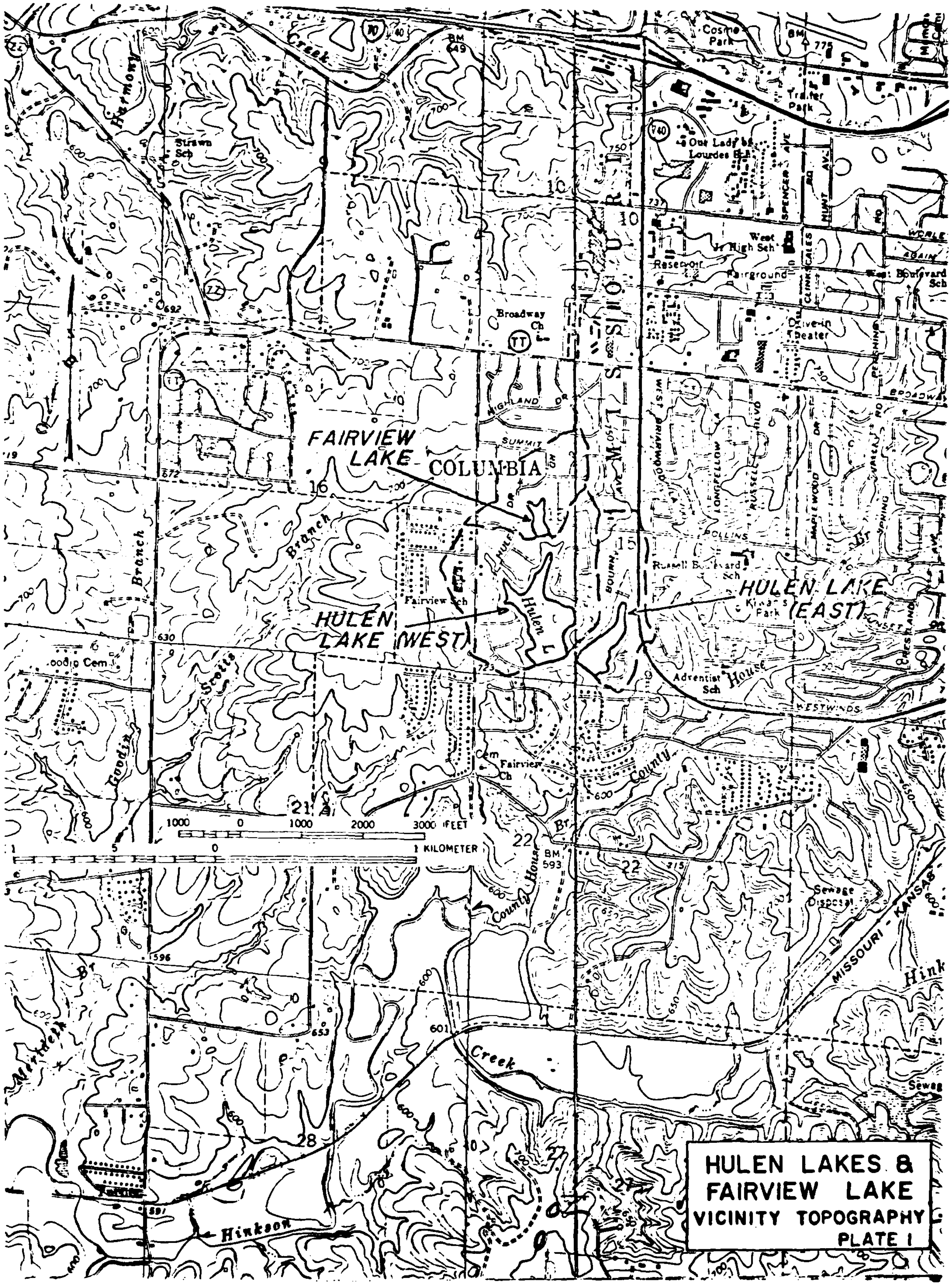
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 WEST LAKE

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	672.40	672.40	675.50
STORAGE	255.	255.	309.
OUTFLOW	0.	0.	105.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	677.49	1.99	344.	3495.	11.17	15.67	0.00
.20	675.16	0.00	303.	94.	0.00	18.08	0.00
.30	675.99	.49	318.	219.	4.00	16.17	0.00
.50	676.86	1.36	333.	1428.	6.83	15.67	0.00

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 29 AUG 78
****


FAIRVIEW LAKE
COLUMBIA
HULEN LAKE (WEST)
HULEN LAKE (EAST)
Hulen L
Fairview Sch
Russell Boulevard Sch
Kiwanis Park
Adventist Sch
Broadway Ch
Fairview Ch
West Jr High Sch
Reservoir
Fairground
Drive-in Theater
Our Lady of Lourdes H.S.
Cosmo Park
Trailer Park
Strawn Sch
Sewage Disposal
MISSOURI - KANSAS
Hinkson
Creek
Harmony
Scotts Branch
Goodin Branch
County House Br
1000 0 1000 2000 3000 FEET
1 .5 0 1 KILOMETER
HULEN LAKES &
FAIRVIEW LAKE
VICINITY TOPOGRAPHY
PLATE I

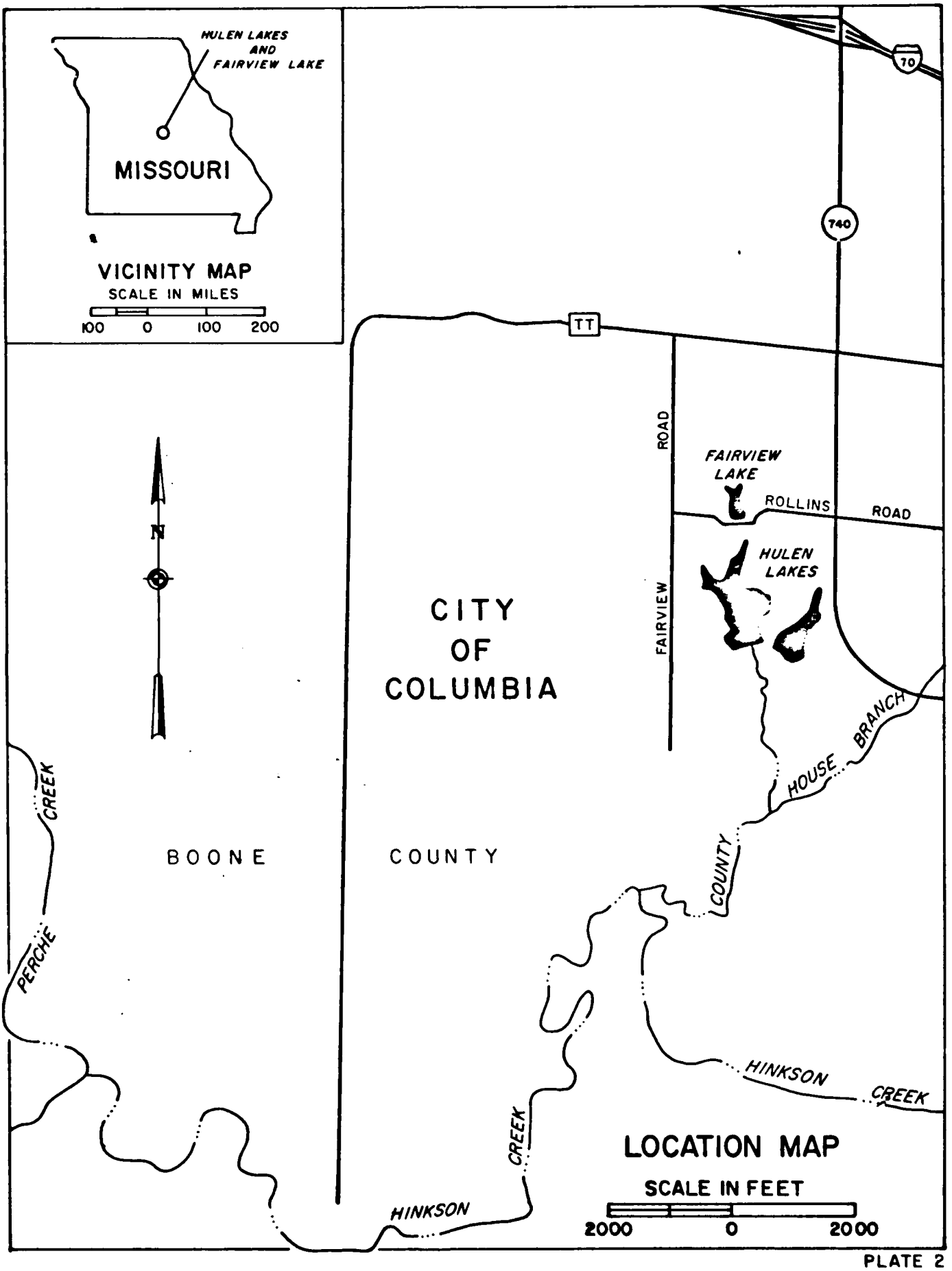
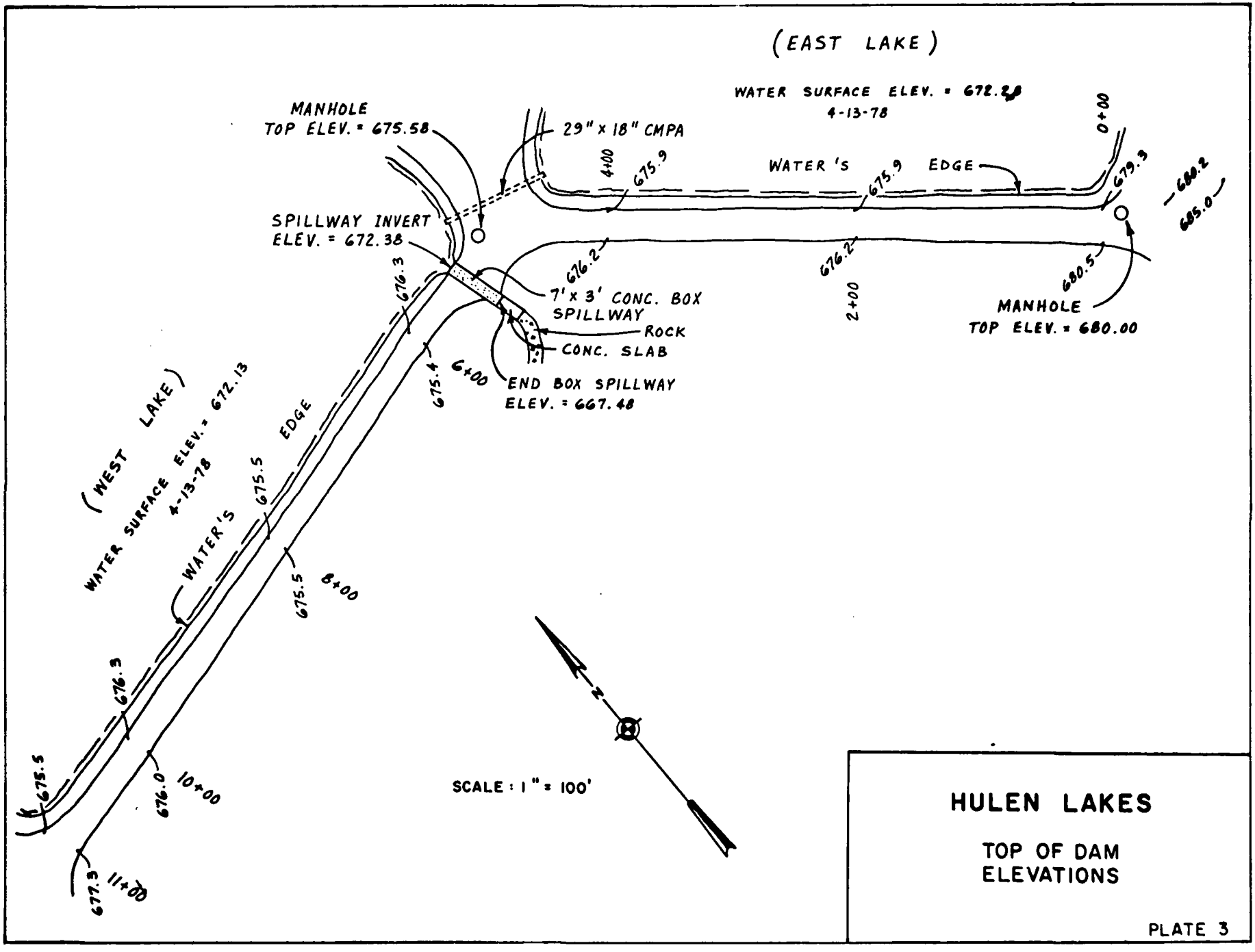

HULEN LAKES AND FAIRVIEW LAKE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
70
740
TT
ROAD
FAIRVIEW LAKE
ROLLINS ROAD
HULEN LAKES
FAIRVIEW
N
CITY OF COLUMBIA
HOUSE BRANCH
CREEK
BOONE
COUNTY
COUNTY
PERCHE
HINKSON CREEK
CREEK
HINKSON
LOCATION MAP
SCALE IN FEET
2000 0 2000

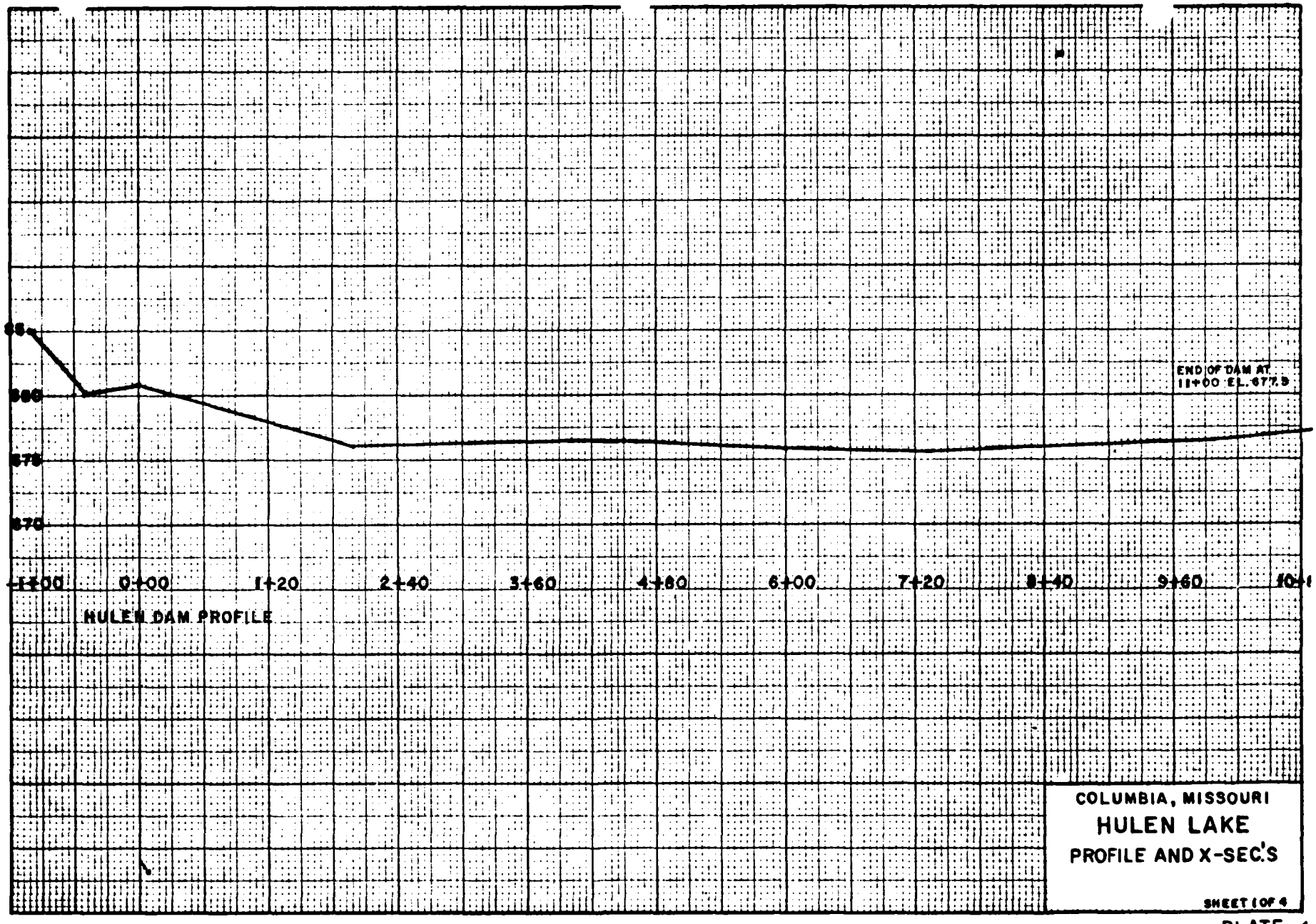
PLATE 2



HULEN LAKES

TOP OF DAM ELEVATIONS

PLATE 3



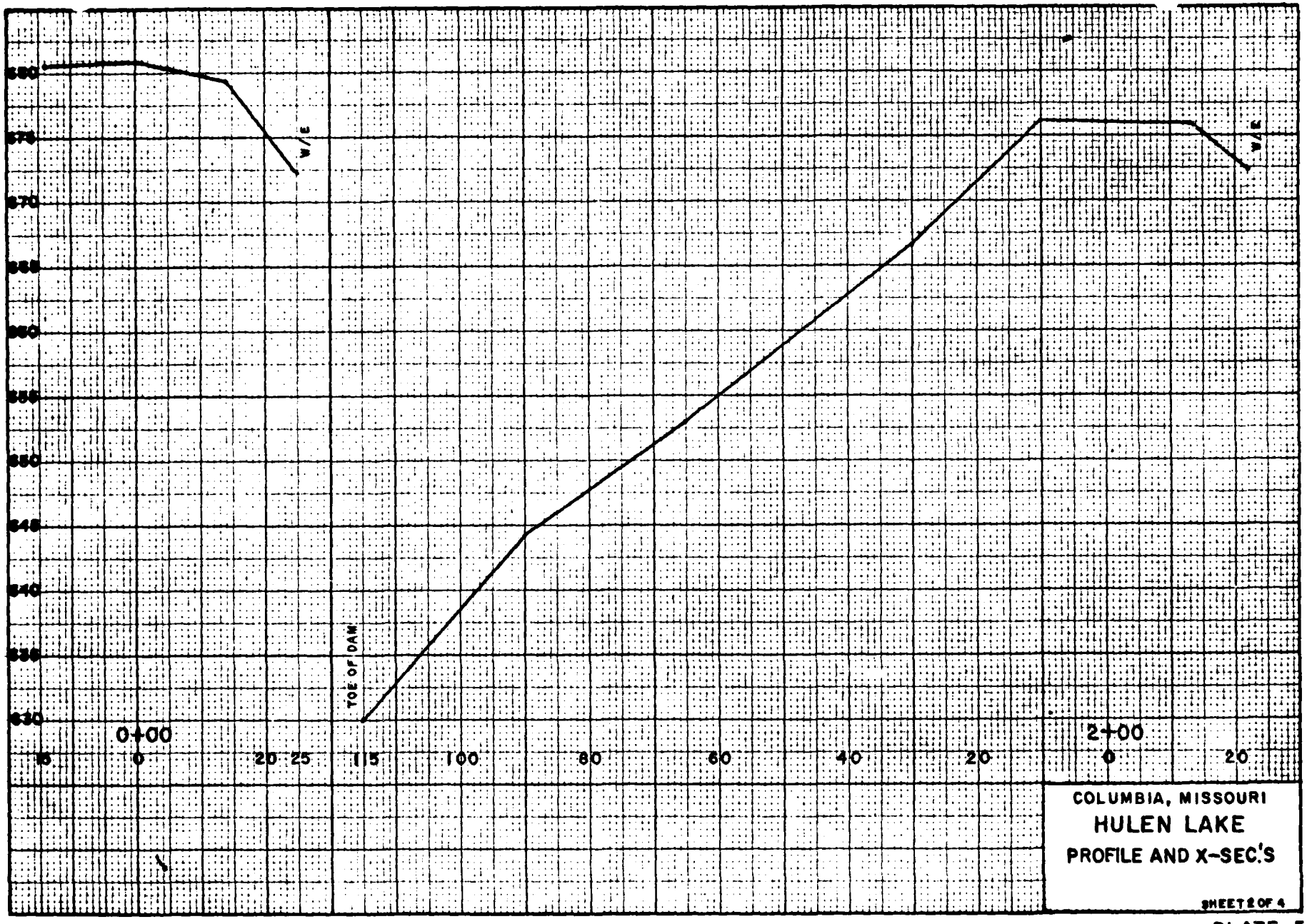
COLUMBIA, MISSOURI

HULEN LAKE

PROFILE AND X-SEC.'S

SHEET 1 OF 4

PLATE 4



COLUMBIA, MISSOURI

HULEN LAKE

PROFILE AND X-SEC.'S

SHEET 2 OF 4

PLATE 5

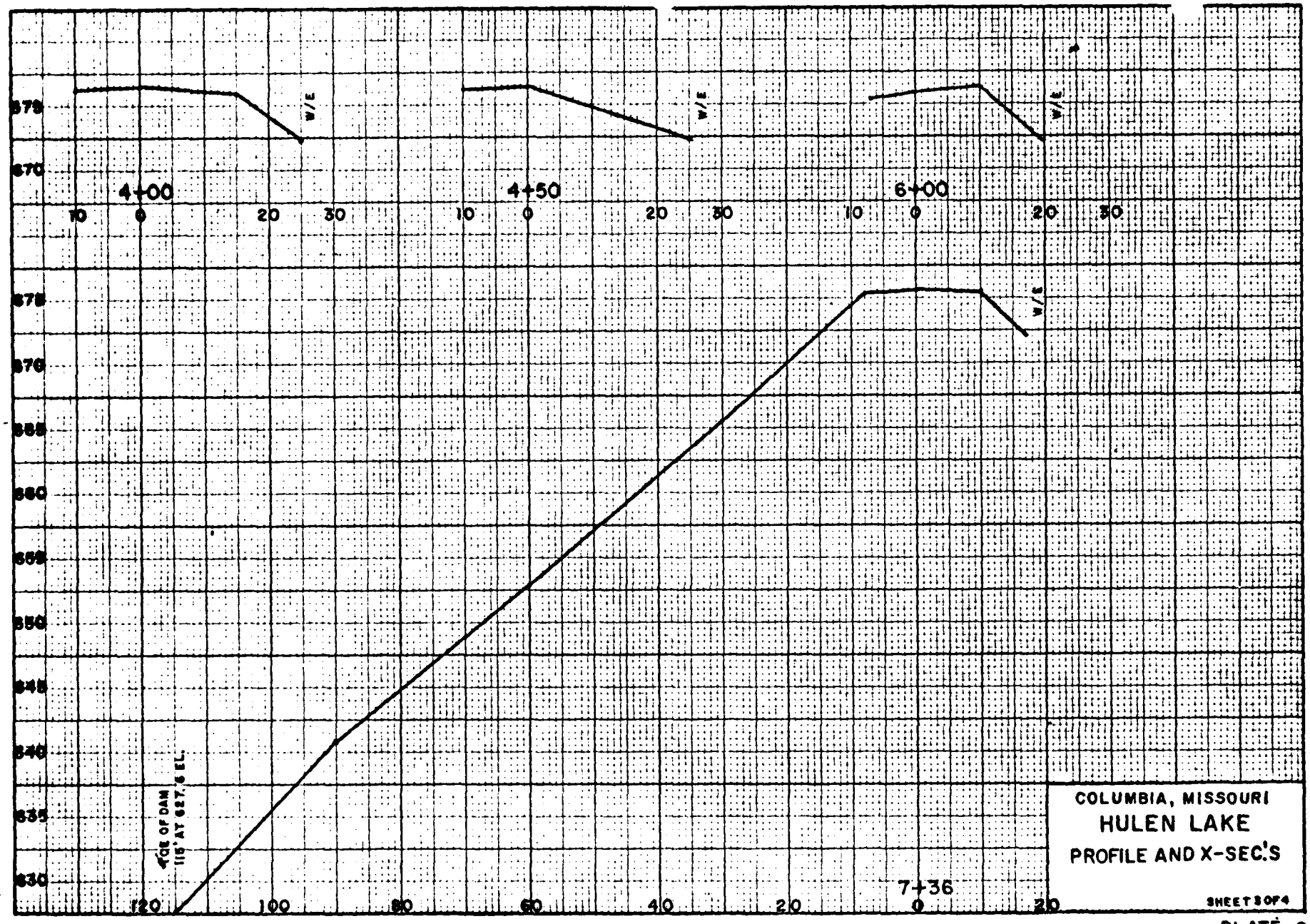
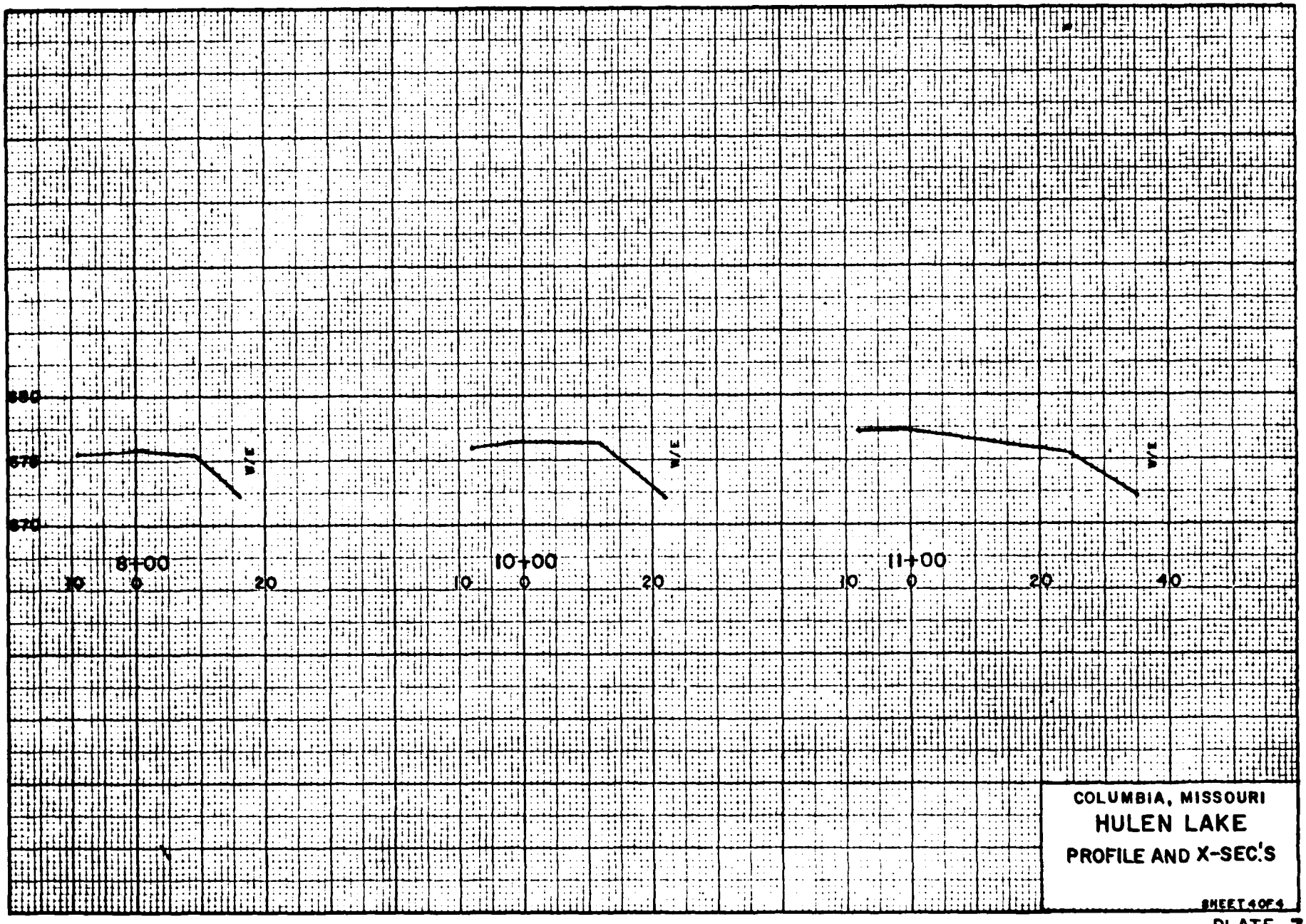

W/E
W/E
W/E
4+00
4+50
6+00
10
0
20
30
10
0
20
30
10
0
20
30
W/S
680
675
670
665
660
655
650
645
640
635
630
120
100
80
60
40
20
0
20
7+36
FACE OF DAM
115' AT 687.5 EL.
COLUMBIA, MISSOURI
HULEN LAKE
PROFILE AND X-SEC.'S
SHEET 3 OF 4

PLATE 6



COLUMBIA, MISSOURI

HULEN LAKE

PROFILE AND X-SEC.'S

SHEET 4 OF 4

PLATE 7

PHOTO 1: CMPA (U/S) Hulen Lake Dam East

PHOTO 2: CMPA (D/S) and Concrete Box, Hulen Lake Dam West

PHOTO 3: Concrete Box (D/S) Hulen Lake Dam West

PHOTO 4: Rock Falls of Hulen Lake Dam West

PHOTO 5

Downstream slope of Hulen Lake Dam West

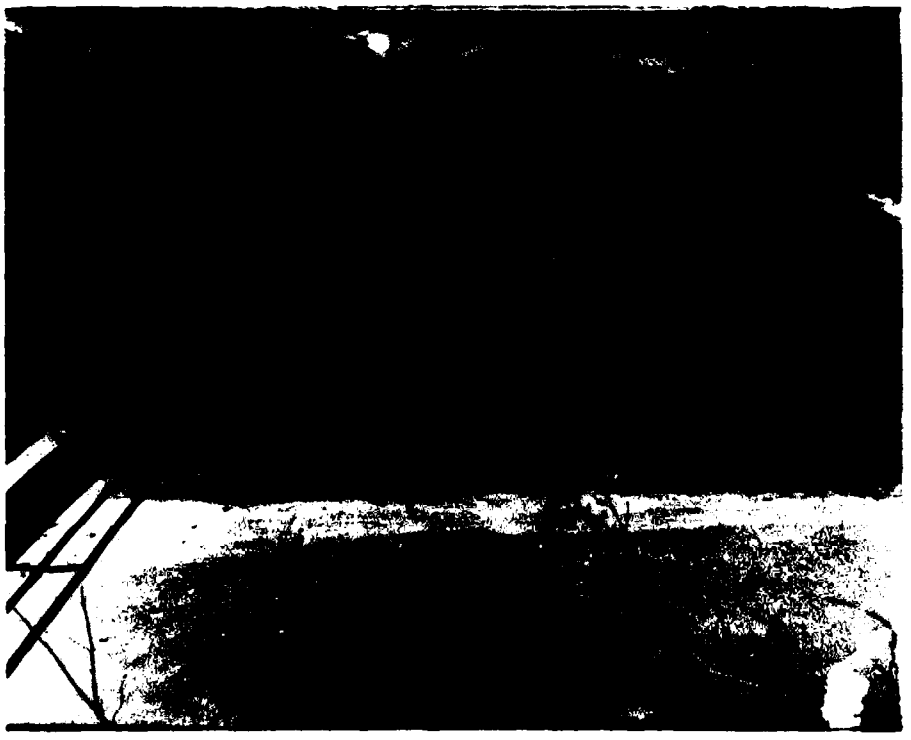


PHOTO 6

Downstream slope of Hulen Lake Dam East

PHOTO 7

Seepage Downstream of Hulen Lake Dam East

PHOTO 8

Seepage Downstream of Hulen Lake Dam West (1 of 3)

PHOTO 9

Seepage Downstream of Hulen Lake Dam West (2 of 3)

PHOTO 10

Seepage Downstream of Hulen Lake Dam West (3 of 3)

PHOTO 11

Downstream of Hulen Lake East (Note Bowed tree trunks)

PHOTO 12

Erosion Downstream of Box Spillway, Hulen Lake Dam West (1 of 2)

PHOTO 13

Erosion Downstream of Box Spillway, Hulen Lake Dam West (2 of 2)